Inside DarkGate: In-Depth Technical Analysis of the Malware-as-a-Service Threat

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Introduction

In this report, I present an extensive, step-by-step static analysis of a real-world sample of the DarkGate Remote Access Trojan (RAT), a sophisticated and highly modular malware that has become emblematic of the Malware-as-a-Service (MaaS) threat landscape. Originally discovered in 2018, DarkGate has evolved to incorporate a broad spectrum of malicious capabilities, including but not limited to remote desktop control, credential theft, keylogging, file exfiltration, cryptomining, and advanced anti-analysis features.

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This document details my methodology, findings, and interpretations derived from a deep static analysis using open-source tools. The goal is to illuminate both the technical mechanisms underlying DarkGate's operations and the analytical workflow required to dissect such a complex threat.

Summary & Key Highlights

- Identified advanced **RAT capabilities**, including keylogging, remote desktop control, credential theft, audio recording, and file exfiltration.
- Performs **in-memory code injection** using `NtWriteVirtualMemory`, avoiding disk artifacts.
- Implements sophisticated **anti-debugging and anti-forensics techniques**, checking for common analysis tools.
- Establishes **stealthy C2 communication** via dynamically loaded Winsock APIs, using legitimate-looking User-Agent strings.
- Leverages `cmdkey` and **NirSoft tools** to exfiltrate browser and email credentials.
- Achieves **persistence** via registry keys, startup folders, and scripting tools like AutoHotkey/AutoIt.
- Extracted numerous **IOCs**, including registry keys, suspicious strings, filenames, directories, and network indicators.

Sample Details

- **MD5 Hash:** 2143d7603258b2801f7ed154b5da3da6
- **SHA256 Hash:** 3c64cbb7e7212d920322dae62665b05ceb63a0ad6074cac3ba518cedc5c6dd48
- **File Size:** 64 bytes (suggesting a loader or dropper, clarified through further analysis)

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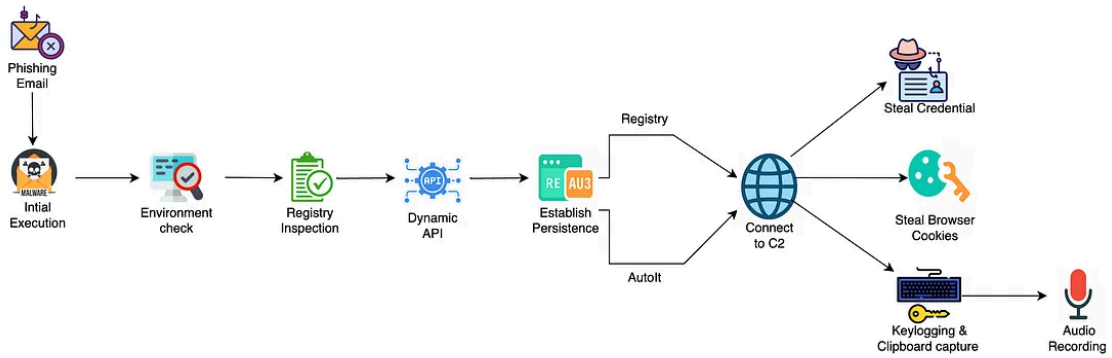

Figure: DarkGate Malware Infection Flow

My workflow began with a high-level triage to understand the file's structure, packing, and surface-level capabilities, followed by a systematic function-by-function reverse engineering process to uncover deeper behavioral logic and evasion techniques.

Static Analysis and Reverse Engineering Findings

1. Initial File Assessment

- **Compiler and Obfuscation:**
  DIE identified Borland Delphi (Object Pascal) as the compiler, with no known commercial packers detected. However, entropy analysis revealed a value of 6.51 in the CODE section, a strong indicator of custom obfuscation or packing.

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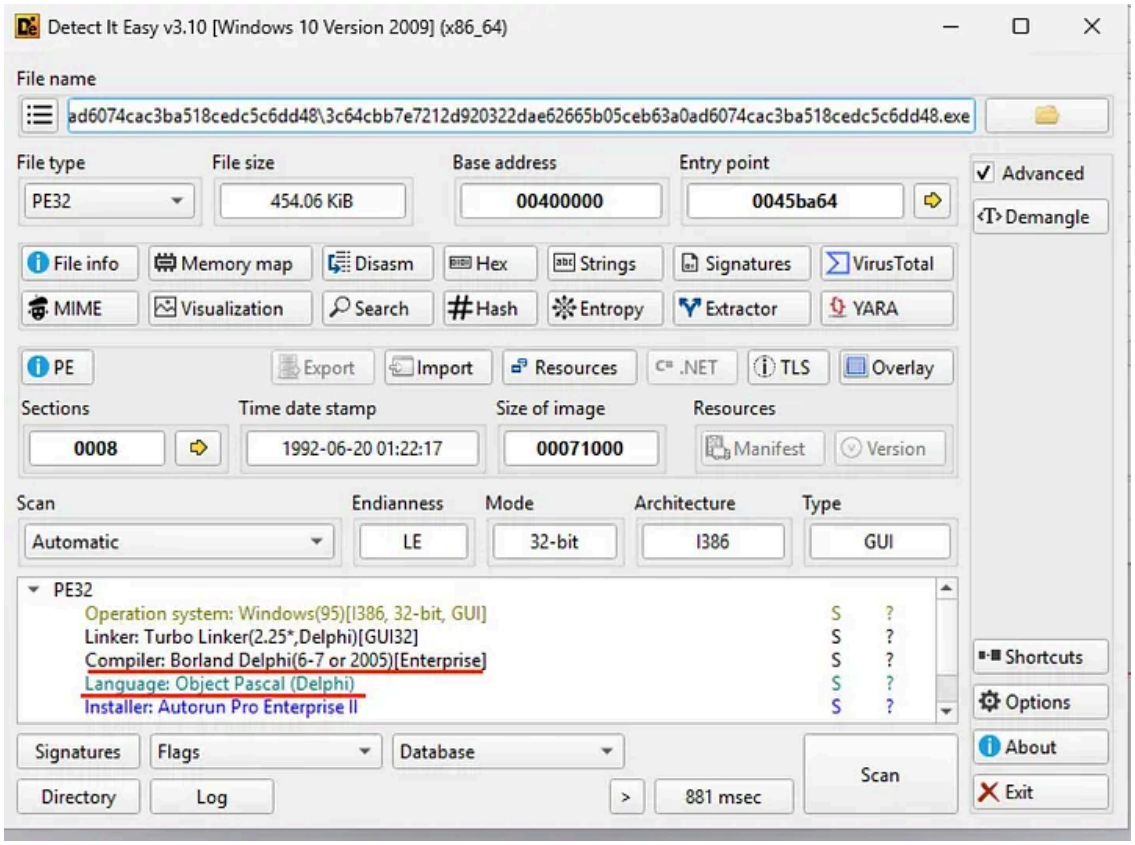

Detect It Easy — Malware information

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Malware entropy analysis

- **API Imports and Capabilities:**
  PeStudio highlighted the presence of APIs associated with process injection (WriteProcessMemory, CreateRemoteThread, VirtualAllocEx), keylogging (GetAsyncKeyState, keybd_event, GetCursorPos), file and clipboard manipulation (ReadFile, WriteFile, CreateFileA/W, OpenClipboard, GetClipboardData), and audio capture (waveInOpen, waveInStart). These imports collectively suggest a RAT with extensive surveillance, data theft, and persistence capabilities.

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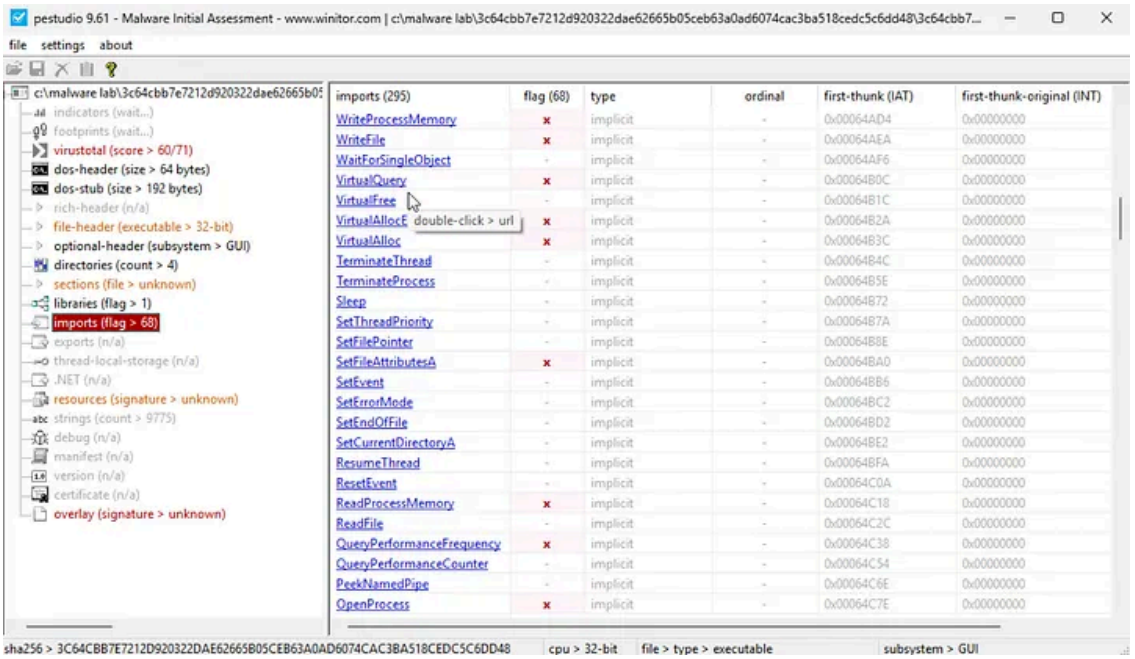

Detected APIs indicate injection, key-logging, and data access capabilities - pestudio

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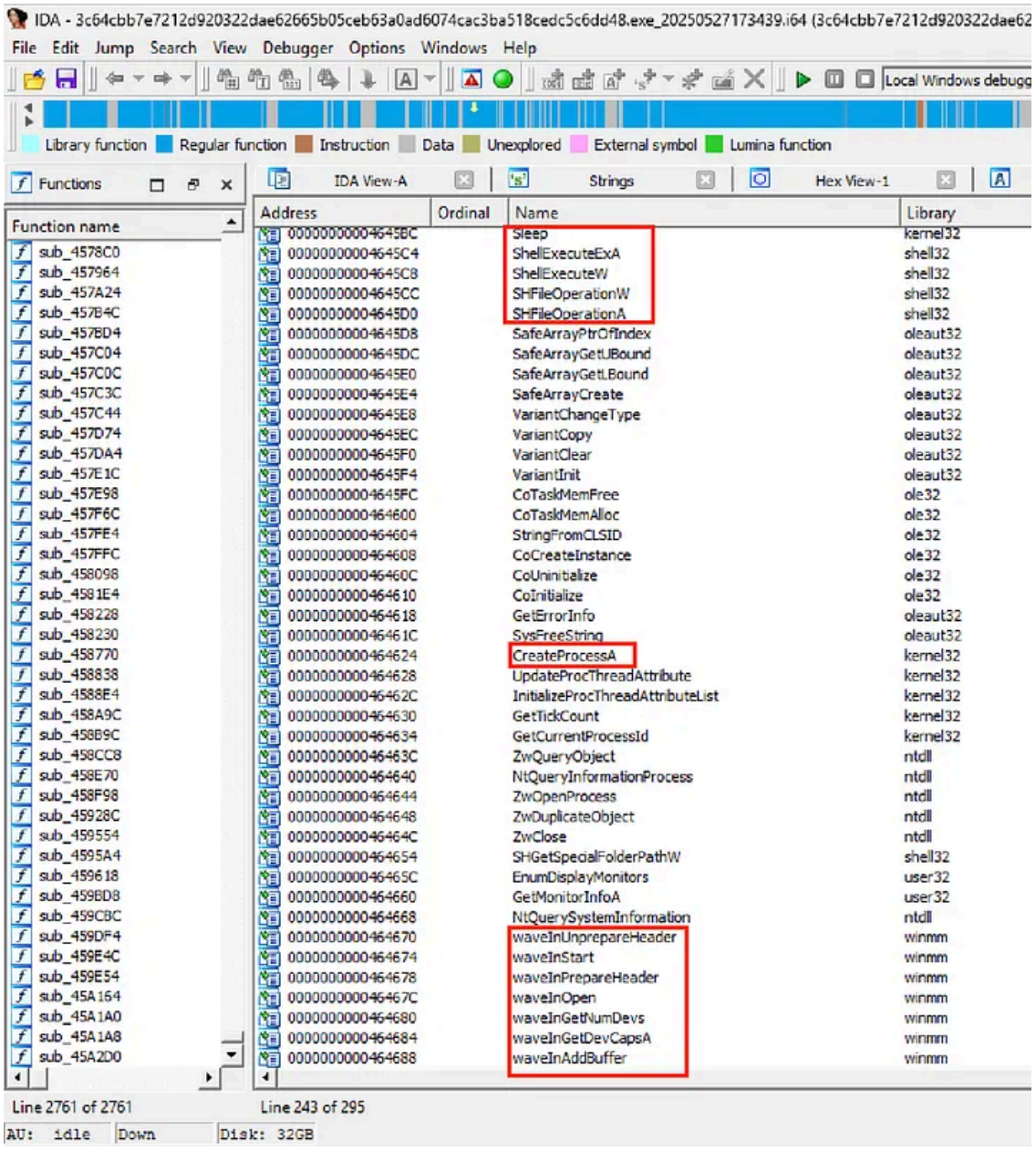

Malware imports table - IDA

2. Registry and Environment Inspection

One of the earliest behaviors observed is the malware's access to the Windows registry, specifically targeting the key SOFTWARE\Borland\Delphi\RTL and querying the value FPUMaskValue using RegOpenKeyExA and RegQueryValueExA. This serves multiple purposes:

- **Configuration Retrieval:** Potentially fetching runtime configuration or operational parameters.
- **Anti-Analysis:** Checking for specific registry values may help the malware identify analysis environments or sandboxes.
- **Attribution:** The focus on Borland Delphi keys further confirms the compiler and development environment used for the malware.

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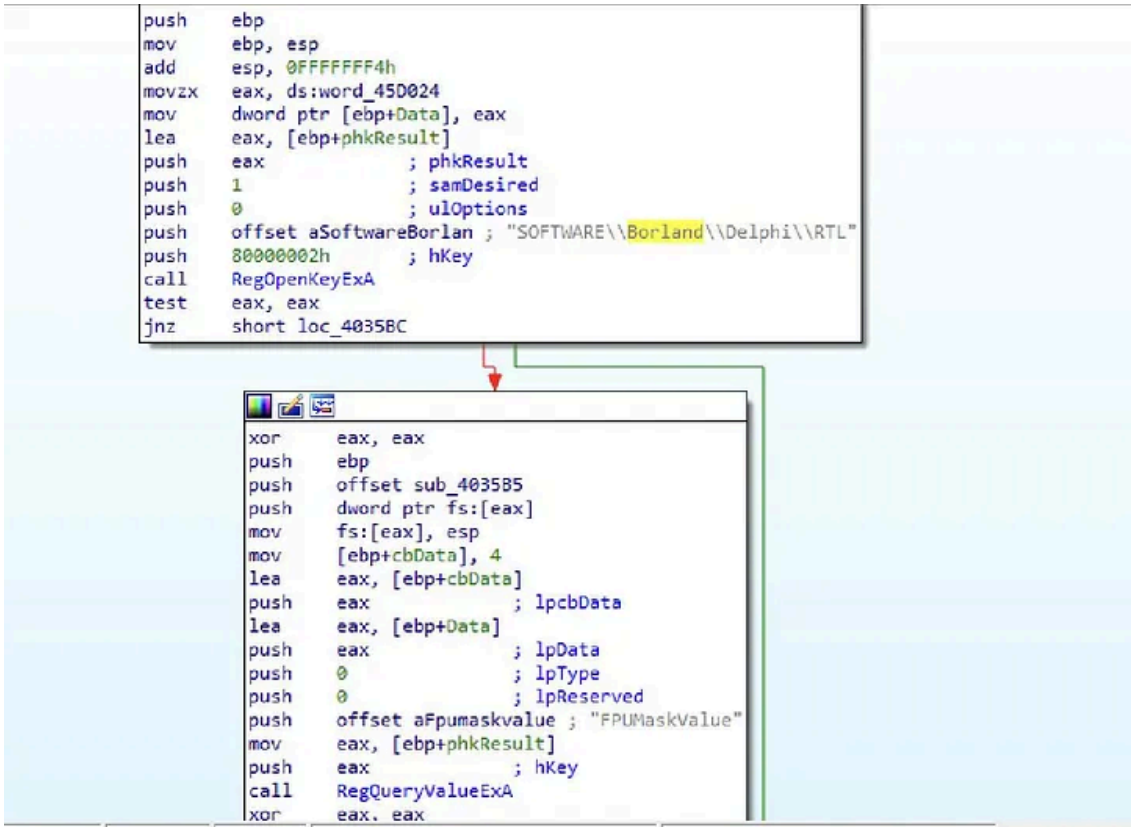

Registry read from Delphi-specific key via RegQueryValueExA

3. Path Manipulation and Anti-Static Analysis

The function sub_405A20 is dedicated to resolving and manipulating filesystem paths. By dynamically loading GetLongPathNameA from kernel32.dll at runtime, DarkGate avoids static detection of its API usage. The function converts short DOS-style paths to their canonical long forms and verifies their existence using FindFirstFileA. It also handles UNC paths (\\server\share), suggesting readiness for network propagation or interaction with shared resources. The use of conditional logic and string operations (lstrcpynA) reveals a deliberate effort to evade static analysis and adapt to varying system configurations.

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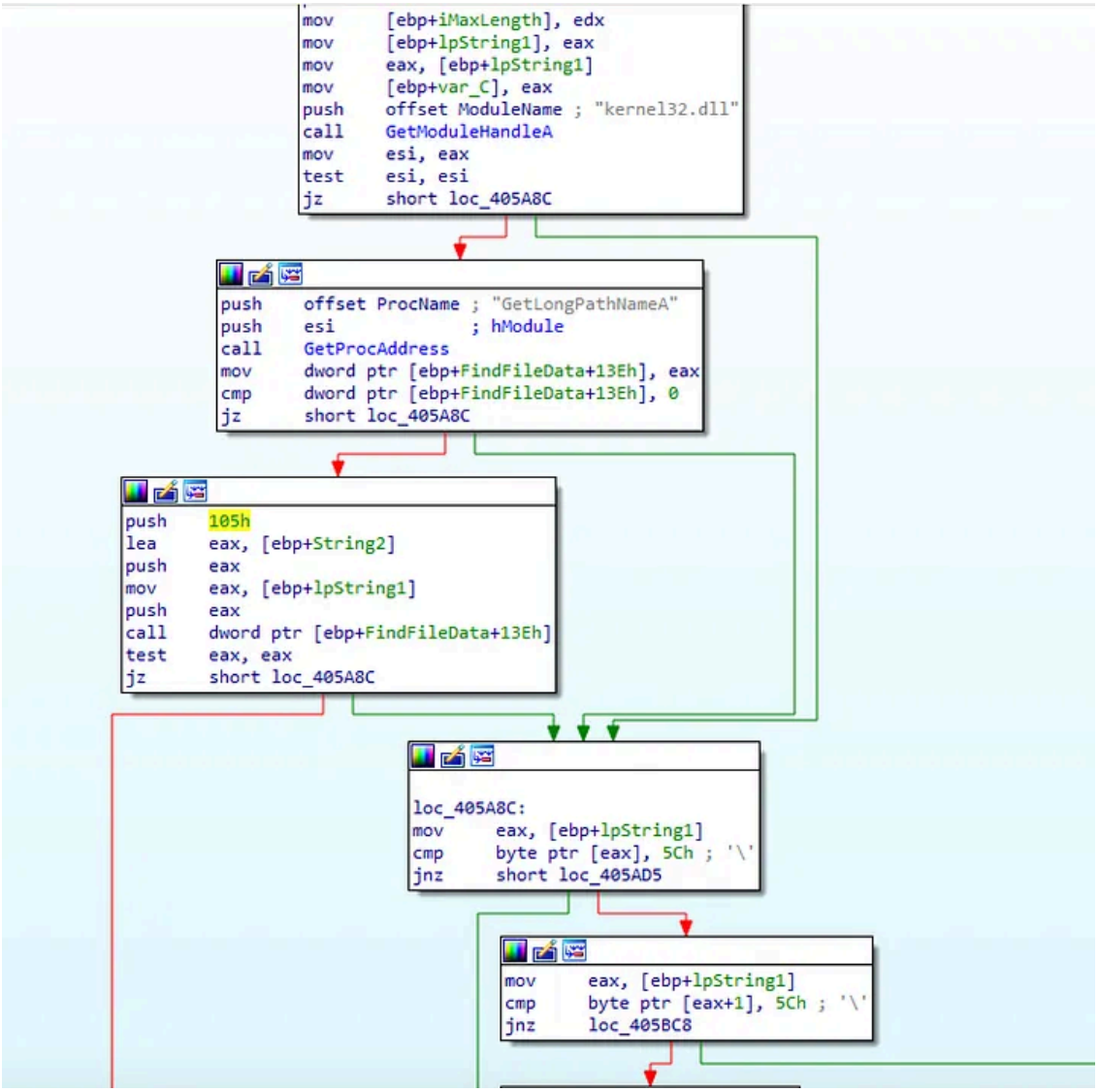

Uses GetLongPathNameA and FindFirstFileA to resolve file paths dynamically

4. Process and Memory Enumeration

The routine sub_40F7C8 demonstrates DarkGate's advanced system reconnaissance abilities. By dynamically resolving APIs such as CreateToolhelp32Snapshot, Process32First/Next, Thread32First/Next, Module32First/Next, and Toolhelp32ReadProcessMemory, the malware gains the ability to:

- Enumerate all running processes, threads, and loaded modules.
- Read memory from other processes, laying the groundwork for process injection, credential theft, and lateral movement.
- Evade static detection by resolving these APIs only at runtime, a hallmark of sophisticated malware.

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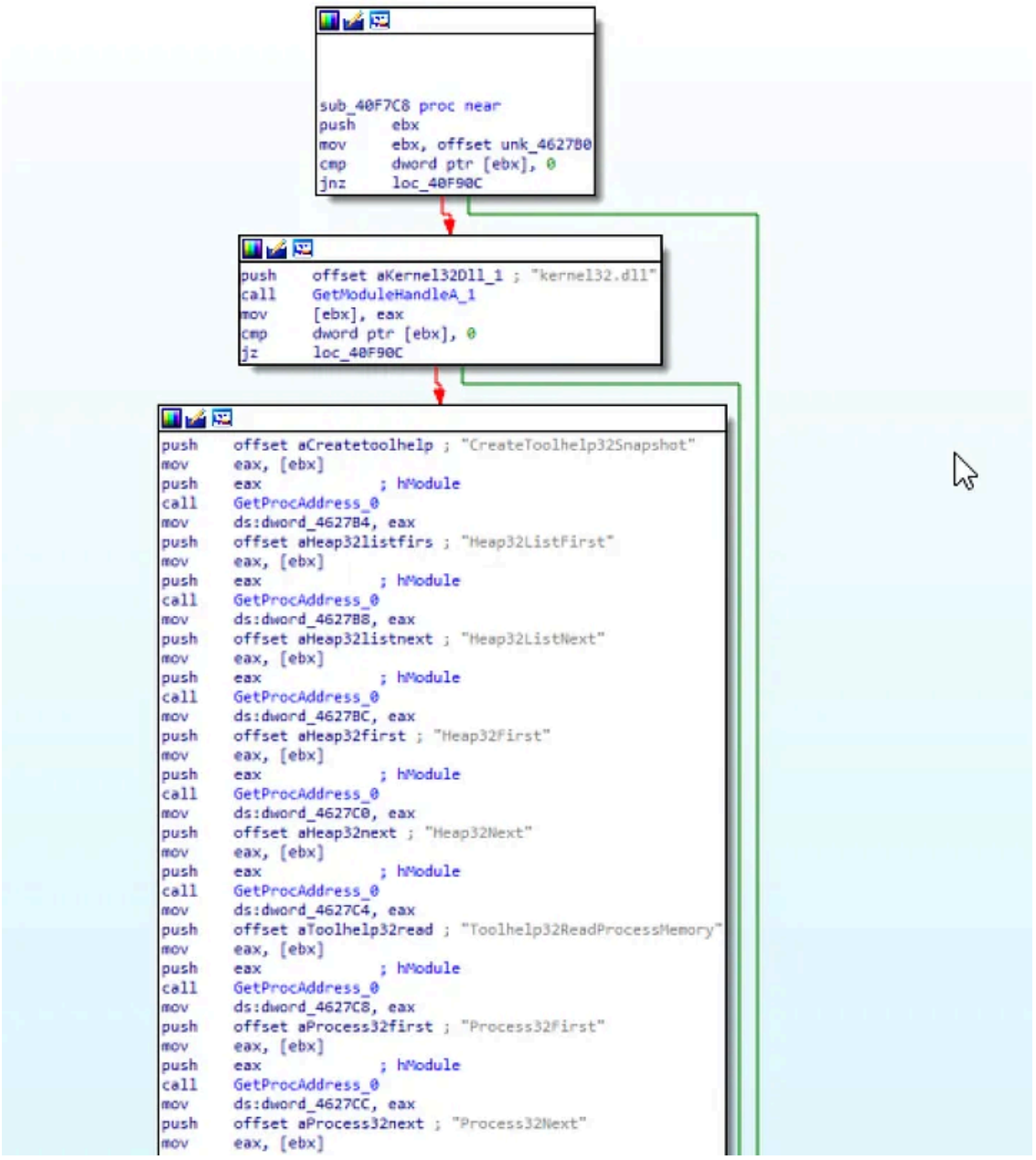

ToolHelp32 APIs resolved at runtime to enumerate system components

5. Variant and COM Data Handling

The function sub_410028 loads numerous OLE automation APIs (e.g., VariantChangeTypeEx, Var*FromStr, VarBstrFrom* from oleaut32.dll). This empowers DarkGate to:

- Seamlessly convert and process various data types (numbers, dates, strings).
- Interact with COM objects and potentially parse complex C2 commands.
- Enhance its adaptability and flexibility in handling data received from or sent to its operators, making it more resilient to changes in C2 protocols or payload formats.

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```
; Attributes: bp-based frame

sub_410028 proc near

var_4= dword ptr -4

push    ebp
mov     ebp, esp
push    ecx
push    offset aOleaut32Dll ; "oleaut32.dll"
call    GetModuleHandleA_1
mov     [ebp+var_4], eax
push    ebp
mov     edx, offset sub_40FB8C
mov     eax, offset aVariantchanget ; "VariantChangeTypeEx"
call    sub_40FFF0
pop     ecx
mov     ds:dword_4627FC, eax
push    ebp
mov     edx, offset sub_40FBBC
mov     eax, offset aVarneg ; "VarNeg"
call    sub_40FFF0
pop     ecx
mov     ds:dword_462800, eax
push    ebp
mov     edx, offset sub_40FBBC
mov     eax, offset aVarnot ; "VarNot"
call    sub_40FFF0
pop     ecx
mov     ds:dword_462804, eax
push    ebp
mov     edx, offset sub_40FBC8
mov     eax, offset aVaradd ; "VarAdd"
call    sub_40FFF0
pop     ecx
mov     ds:dword_462808, eax
push    ebp
mov     edx, offset sub_40FBC8
mov     eax, offset aVarsub ; "VarSub"
call    sub_40FFF0
pop     ecx
mov     ds:dword_46280C, eax
push    ebp
mov     edx, offset sub_40FBC8
mov     eax, offset aVarmul ; "VarMul"
call    sub_40FFF0
pop     ecx
mov     ds:dword_462810, eax
push    ebp
mov     edx, offset sub_40FBC8
mov     eax, offset aVardiv ; "VarDiv"
call    sub 40FFF0
```

Loads Variant APIs from oleaut32.dll to parse dynamic data types

6. Security Software Evasion

DarkGate systematically checks for directories and files associated with a wide array of antivirus products (Bitdefender, SentinelOne, Avast, AVG, Kaspersky, Norton, Symantec, Trend Micro, McAfee, SUPER AntiSpyware, Comodo, MalwareBytes, among others). This is a classic evasion technique:

- **Detection Avoidance:** If security software is detected, DarkGate may alter its behavior, disable certain features, or even uninstall itself to avoid detection.

- **Persistence:** By ensuring it does not operate in hostile environments, the malware increases its chances of long-term persistence.

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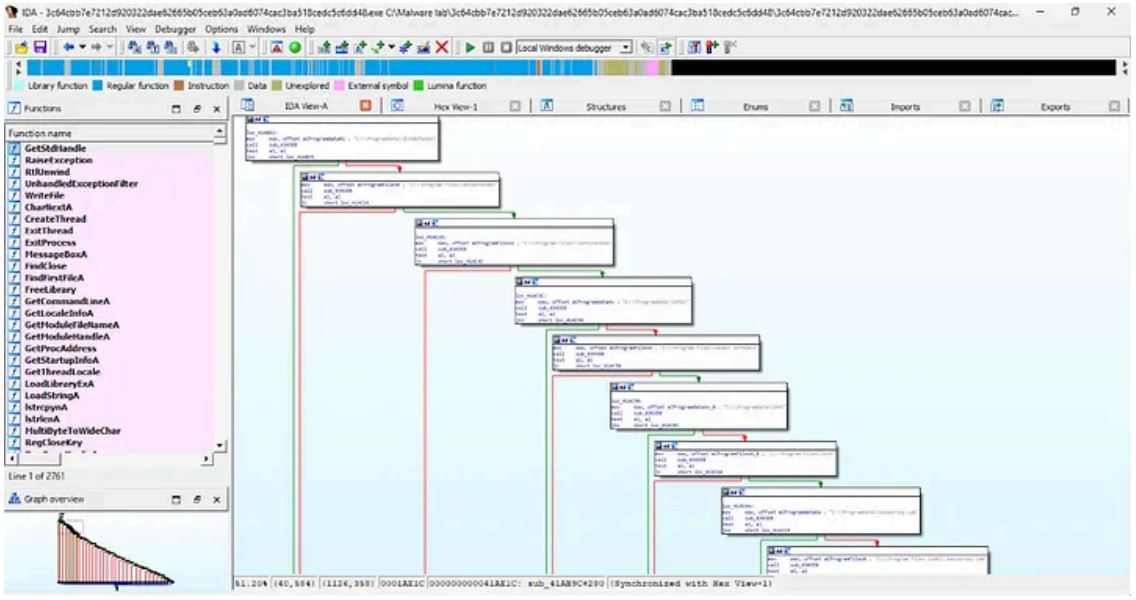

Checks for antivirus and forensic tools in system directories

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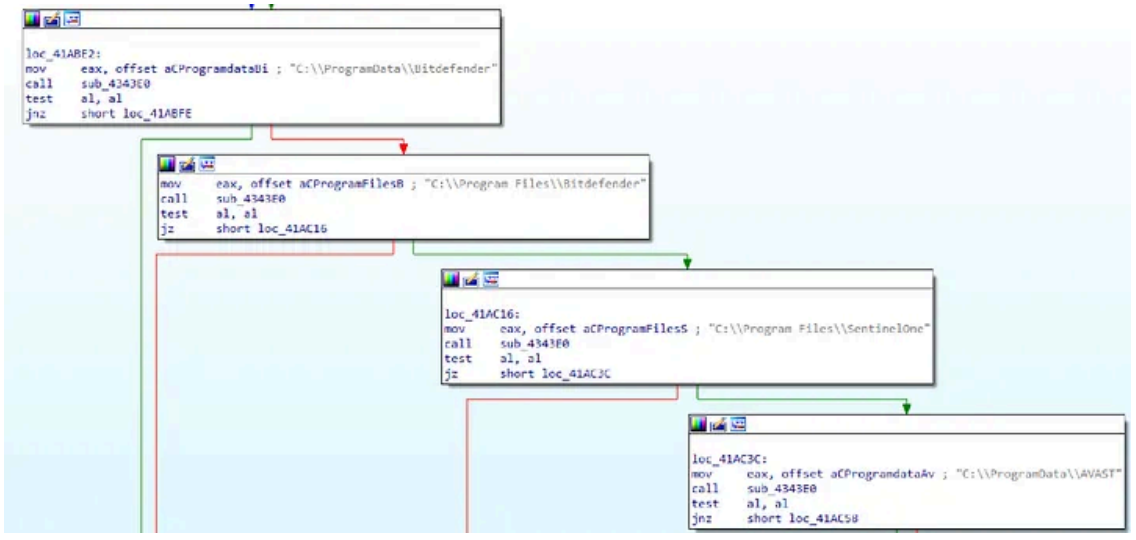

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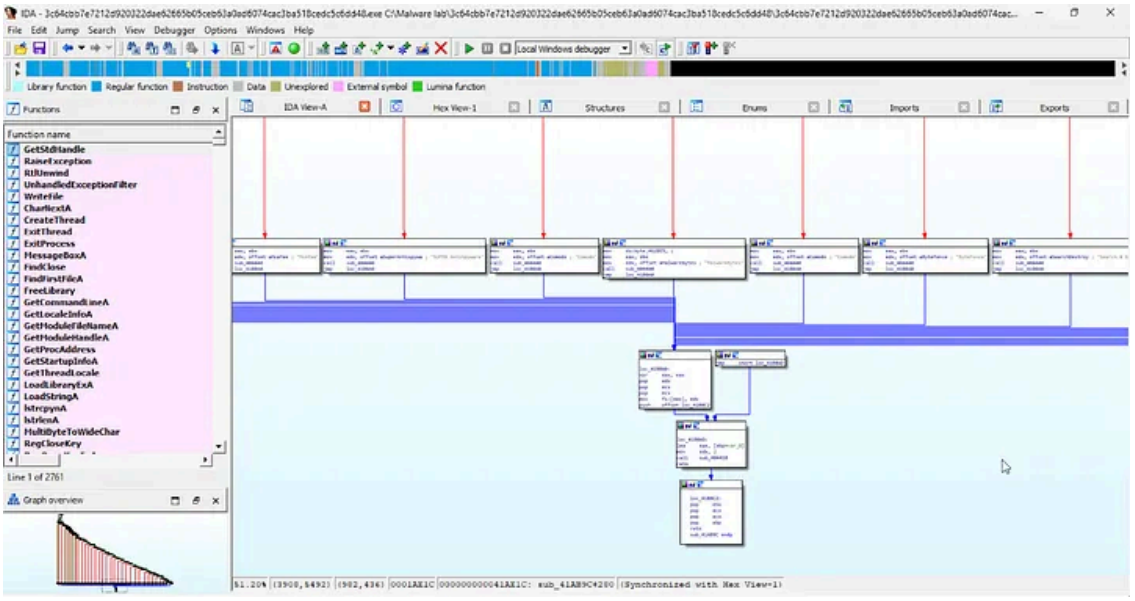

7. Stealthy Network Communication

The function sub_41CAC0 dynamically loads Winsock APIs (WSAStartup, send, recv) from ws2_32.dll at runtime. This approach:

- **Evasion:** Avoids static detection by security solutions scanning for networking imports.
- **Flexibility:** Allows the malware to establish covert C2 channels, exfiltrate data, and receive commands while blending in with legitimate network traffic.

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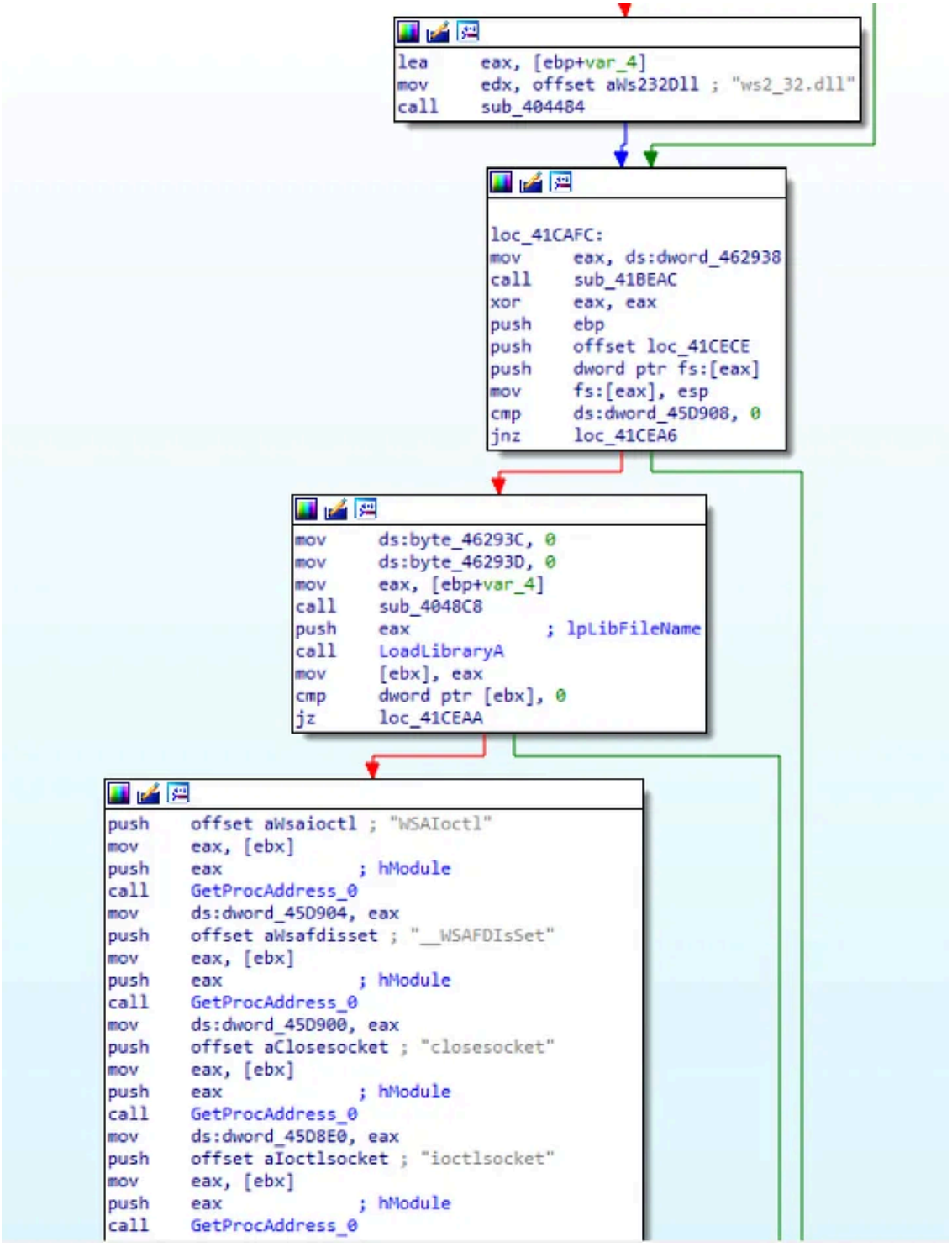

Winsock APIs resolved dynamically

Furthermore, DarkGate crafts its C2 traffic to mimic legitimate web traffic by:

- Using port 8080 (commonly associated with web services).
- Embedding a full “Mozilla/5.0…” User-Agent string.

  This enables its malicious communications to blend seamlessly into normal web traffic, significantly increasing its chances of bypassing network security measures.

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```
CODE:004252B3        call    sub_4222C4
CODE:004252B8        mov     dword ptr [edi+10h], 493E0h
CODE:004252BF        lea     eax, [edi+8]
CODE:004252C2        mov     edx, offset dword_425364
CODE:004252C7        call    sub_404440
CODE:004252CC        lea     eax, [edi+48h]
CODE:004252CF        call    sub_4043EC
CODE:004252D4        lea     eax, [edi+4Ch]
CODE:004252D7        mov     edx, offset a8080 ; "8080"
CODE:004252DC        call    sub_404440
CODE:004252E1        lea     eax, [edi+50h]
CODE:004252E4        call    sub_4043EC
CODE:004252E9        lea     eax, [edi+54h]
CODE:004252EC        call    sub_4043EC
CODE:004252F1        lea     eax, [edi+24h]
CODE:004252F4        call    sub_4043EC
CODE:004252F9        lea     eax, [edi+28h]
CODE:004252FC        call    sub_4043EC
CODE:00425301        lea     eax, [edi+38h]
CODE:00425304        mov     edx, offset dword_425380
CODE:00425309        call    sub_404440
CODE:0042530E        mov     byte ptr [edi+3Ch], 1
CODE:00425312        mov     byte ptr [edi+44h], 0
CODE:00425316        lea     eax, [edi+60h]
CODE:00425319        mov     edx, offset aMozilla50Windo ; "Mozilla/5.0 (Windows NT 10.0; Win64; x6"...
CODE:0042531E        call    sub_404440
CODE:00425323        xor     eax, eax
CODE:00425325        mov     [edi+68h], eax
CODE:00425328        xor     eax, eax
CODE:0042532A        mov     [edi+6Ch], eax
CODE:0042532D        mov     byte ptr [edi+78h], 1
CODE:00425331        mov     dword ptr [edi+40h], 12Ch
CODE:00425338        mov     eax, edi
```

HTTP headers mimic browser traffic

8. Code Injection and Memory Residency

The function sub_427EE4 leverages low-level Windows APIs (NtWriteVirtualMemory, NtProtectVirtualMemory) to inject malicious code into other processes. This technique:

- **In-Memory Execution:** Allows the malware to run without ever touching disk, making detection and forensic analysis much more difficult.
- **Persistence:** Maintains control over the infected system even if the original process is terminated.

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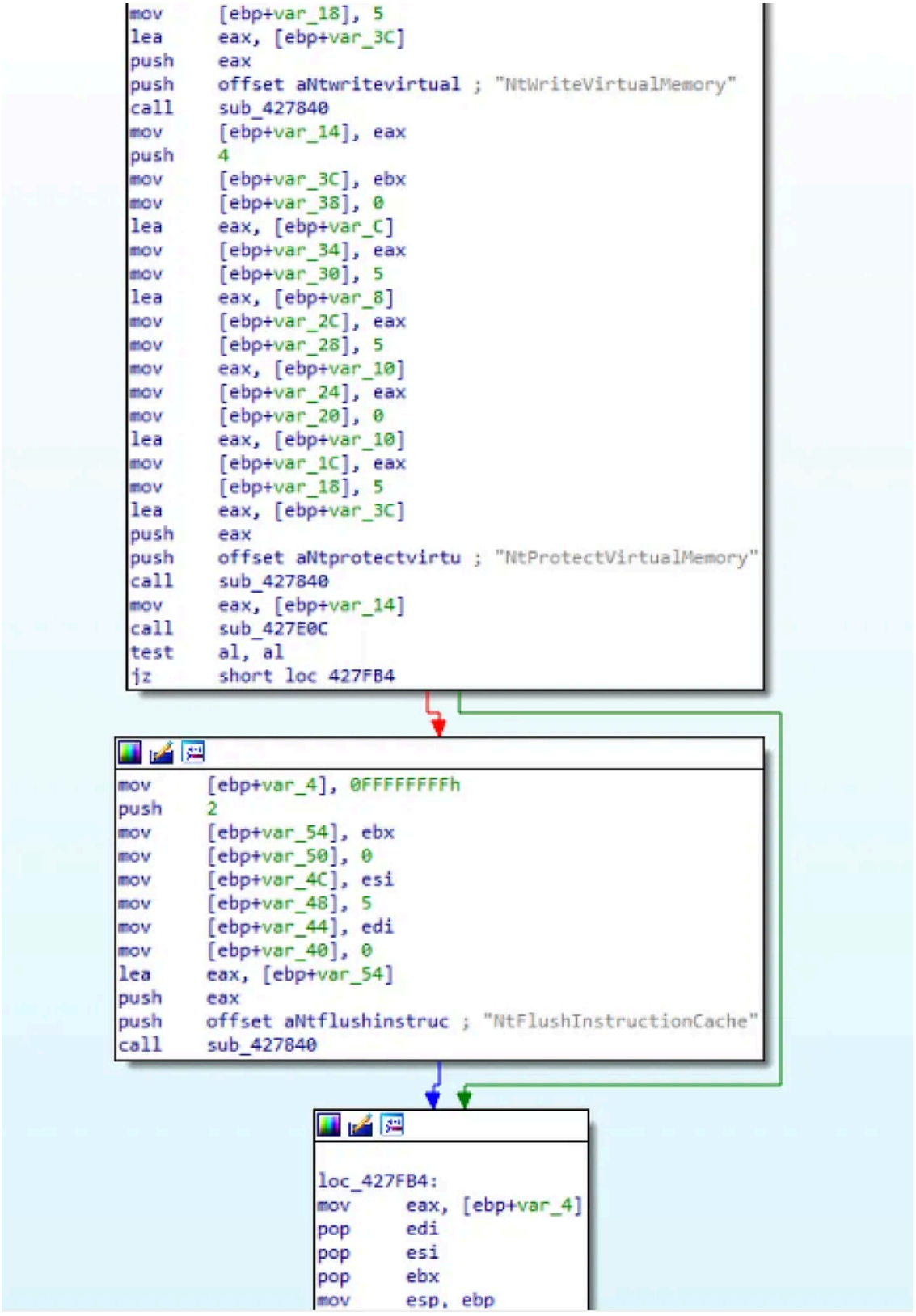

Injects shellcode using NtWriteVirtualMemory & runs in-memory.

9. Persistence Mechanisms

DarkGate ensures its continued execution through multiple persistence strategies:

- **File System:** Uses SHGetSpecialFolderPathW with CSIDL_STARTUP and CSIDL_DESKTOP to locate standard Windows directories, then moves or copies itself using SHFileOperationW to these locations for automatic execution on startup or user login.
- **Registry:** Attempts to create entries under SOFTWARE\Microsoft\Windows\CurrentVersion\Run to guarantee launch at every system boot.
- **Scripted Execution:** Tries to run AutoHotkey.exe or AutoIt3.exe with malicious scripts, leveraging legitimate automation tools to evade detection and facilitate persistence.

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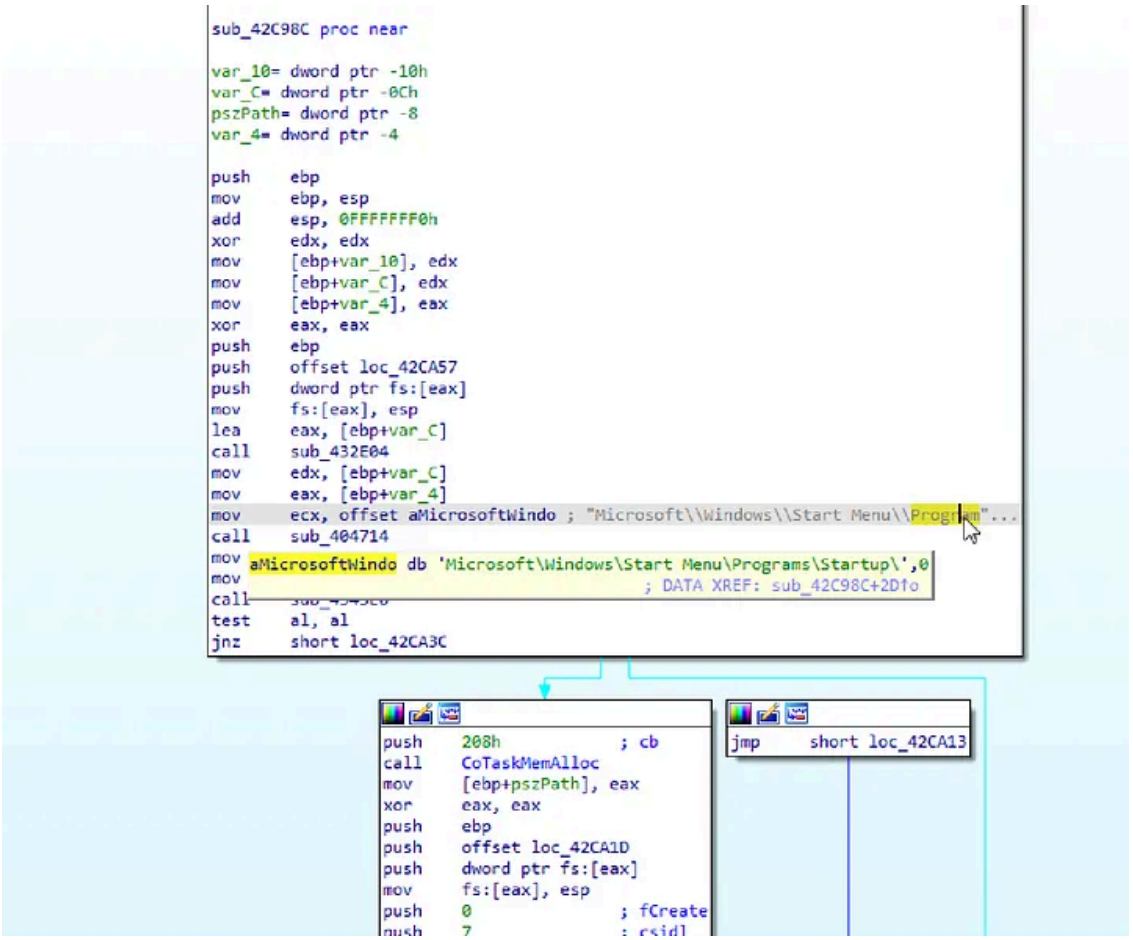

SHGetSpecialFolderPathW and SHFileOperation used for startup persistence.

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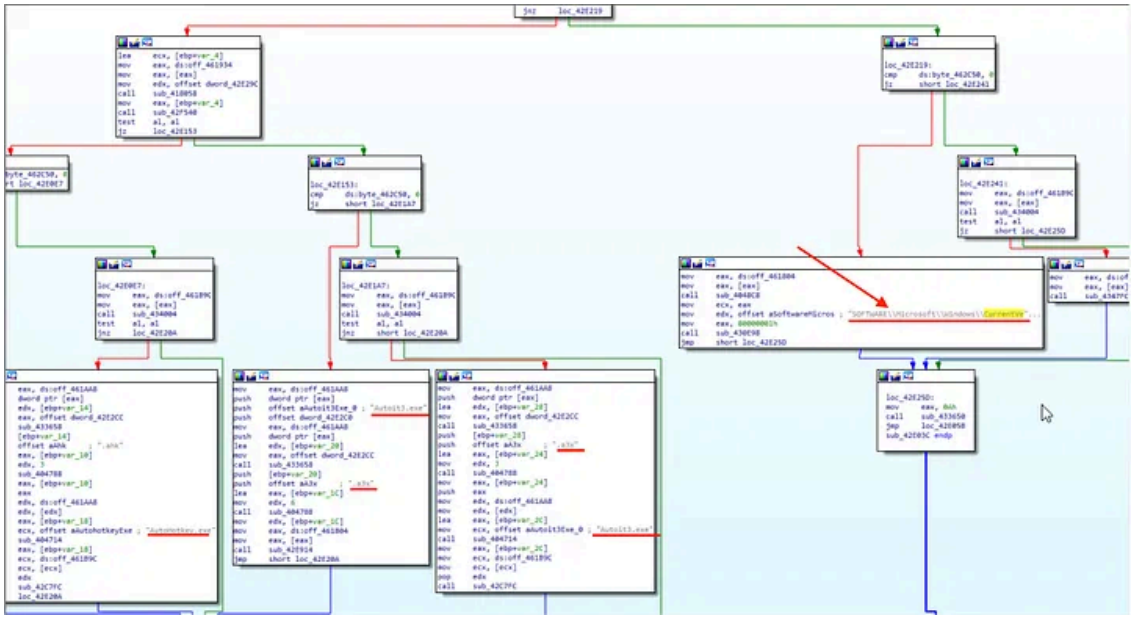

AutoHotkey.exe or AutoIt3.exe with malicious scripts

10. Anti-Debugging and Anti-Analysis

DarkGate employs a robust set of anti-analysis techniques:

- **Debugger Detection:** The function sub_42D594 checks for the presence of debugging tools, introduces execution delays (Sleep), and manipulates files/processes to frustrate analysis.
- **Security Tool Scanning:** The function sub_42DB04 searches for popular security and analysis tools (Malwarebytes, Avast, Wireshark, Process Monitor, Autoruns, Task Manager, Regedit, etc.) in multiple languages. If found, the malware may terminate, hide, or alter its behavior to avoid detection, significantly complicating the work of analysts.

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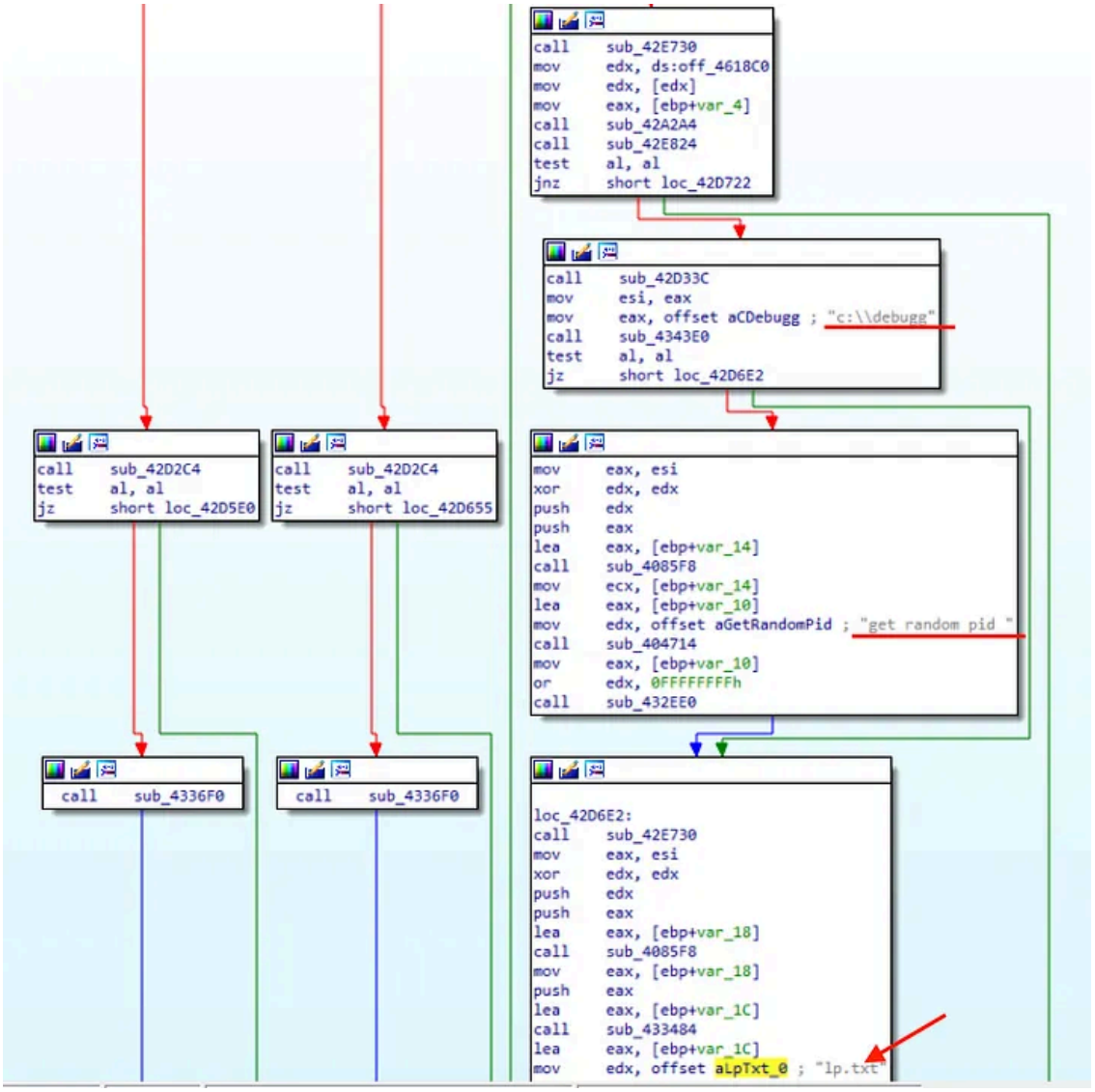

sub_42D594 checks for the presence of debugging tools

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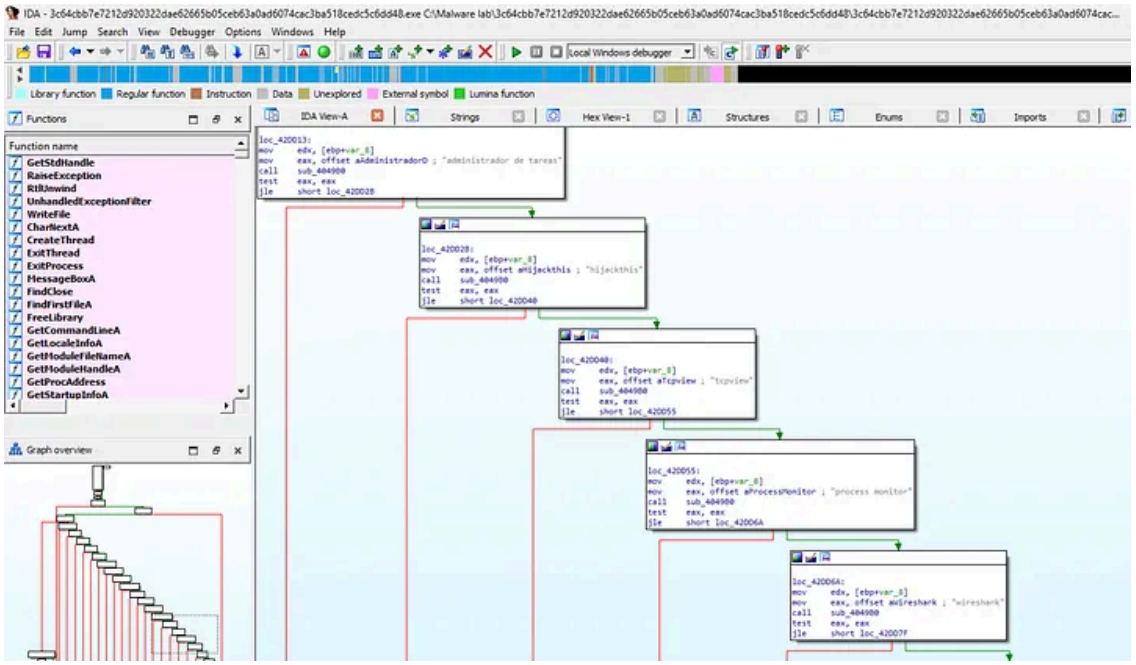

DarkGate checks for tools like Wireshark, ProcMon, and Regedit. The code includes delays (Sleep) and behavior change triggers if tools are detected.

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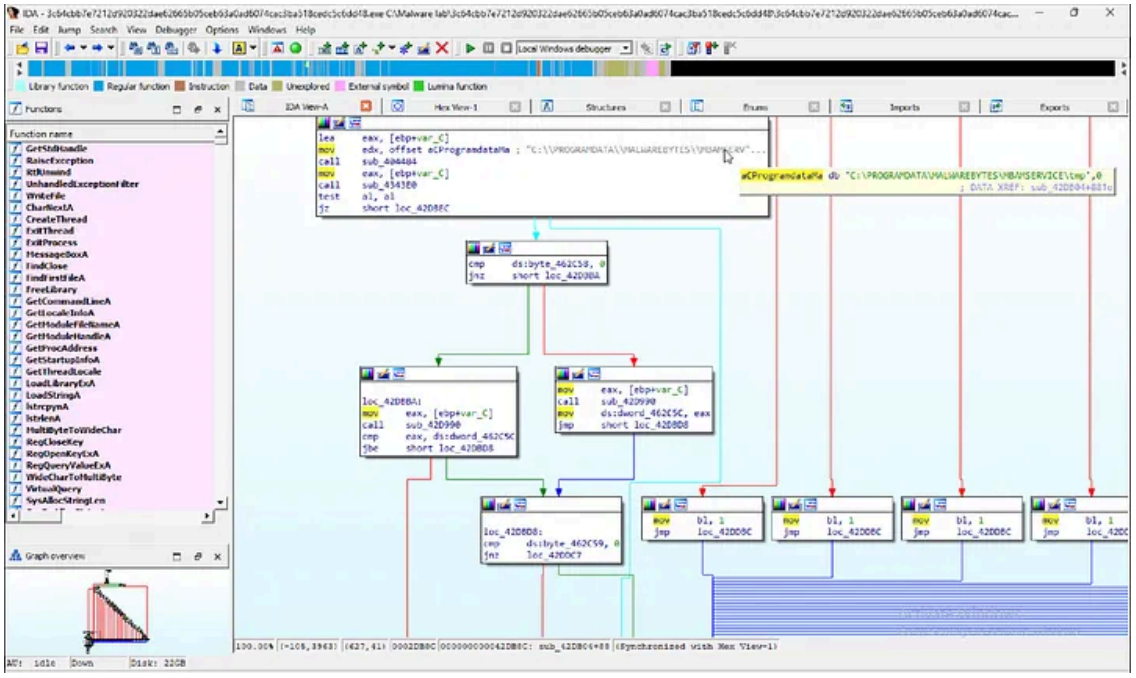

11. Configuration and Debug Modes

The initialization routine sub_42F7A0 sets up operational directories within C:\ProgramData\ (e.g., mainfolder, logsfolder, settings). It checks for a “debug mode” flag and attempts to connect to 127.0.0.1:8094 — likely a local C2 test or fallback channel. If debug mode is disabled, it loads configuration parameters (such as C2 domains, notification settings, and epoch values) from files or the registry, validating port values and preparing for subsequent network communication.

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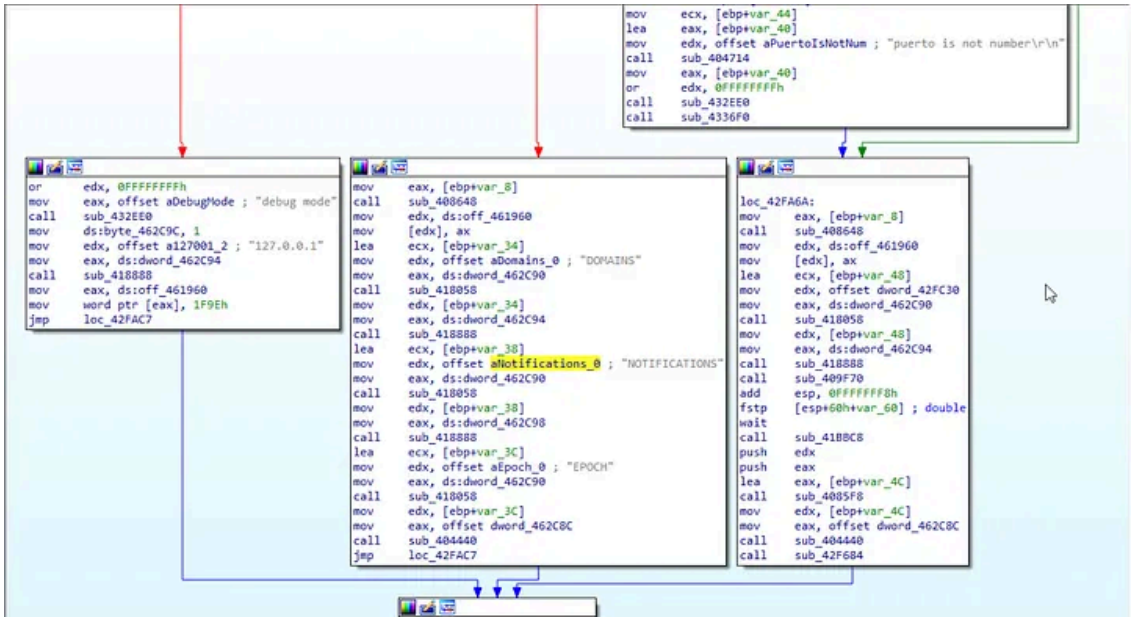

The screenshot shows `127.0.0.1:8094` being used as a potential debug/test C2

12. Browser Data and Cookie Theft

DarkGate aggressively targets browser data:

- **Directory Scanning:** Searches for “chrome”, “edge”, and “brave” directories, specifically seeking “User Data” and “Default\Network\Cookies” paths.
- **Profile Iteration:** Iterates through multiple browser profiles to locate and exfiltrate cookies.
- **Session Hijacking:** By stealing cookies, DarkGate can bypass password-based authentication, enabling attackers to hijack user sessions on various platforms without needing actual credentials.

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```
CODE:00455FFD                 mov     eax, [ebp+var_8]
CODE:00456000                 mov     edx, offset aChrome ; "chrome"
CODE:00456005                 call    sub_404814
CODE:0045600A                 jnz     short loc_456026
CODE:0045600C                 lea     eax, [ebp+var_10]
CODE:0045600F                 call    sub_432D3C
CODE:00456014                 mov     edx, [ebp+var_10]
CODE:00456017                 lea     eax, [ebp+var_C]
CODE:0045601A                 mov     ecx, offset aGoogleChromeUs ; "Google\\Chrome\\User Data\\"
CODE:0045601F                 call    sub_404714
CODE:00456024                 jmp     short loc_456076
CODE:00456026 ; ---------------------------------------------------------------------------
CODE:00456026
CODE:00456026 loc_456026:                             ; CODE XREF: sub_455FD0+3A↑j
CODE:00456026                 mov     eax, [ebp+var_8]
CODE:00456029                 mov     edx, offset aEdge ; "edge"
CODE:0045602E                 call    sub_404814
CODE:00456033                 jnz     short loc_45604F
CODE:00456035                 lea     eax, [ebp+var_14]
CODE:00456038                 call    sub_432D3C
CODE:0045603D                 mov     edx, [ebp+var_14]
CODE:00456040                 lea     eax, [ebp+var_C]
CODE:00456043                 mov     ecx, offset aMicrosoftEdgeU ; "Microsoft\\Edge\\User Data\\"
CODE:00456048                 call    sub_404714
CODE:0045604D                 jmp     short loc_456076
CODE:0045604F ; ---------------------------------------------------------------------------
CODE:0045604F
CODE:0045604F loc_45604F:                             ; CODE XREF: sub_455FD0+63↑j
CODE:0045604F                 mov     eax, [ebp+var_8]
CODE:00456052                 mov     edx, offset aBrave ; "brave"
CODE:00456057                 call    sub_404814
CODE:0045605C                 jnz     short loc_456076
CODE:0045605E                 lea     eax, [ebp+var_18]
CODE:00456061                 call    sub_432D3C
CODE:00456066                 mov     edx, [ebp+var_18]
CODE:00456069                 lea     eax, [ebp+var_C]
CODE:0045606C                 mov     ecx, offset aBravesoftwareB ; "BraveSoftware\\Brave-Browser\\User Data"...
CODE:00456071                 call    sub_404714
CODE:00456076
CODE:00456076 loc_456076:                             ; CODE XREF: sub_455FD0+54↑j
CODE:00456076                                         ; sub_455FD0+7D↑j ...
CODE:00456076                 lea     eax, [ebp+var_1C]
CODE:00456079                 mov     ecx, offset aDefault_0 ; "Default\\"
CODE:0045607E                 mov     edx, [ebp+var_C]
```

This function locates browser profiles and cookie storage paths (`Network\\Cookies`) for exfiltration

13. Browser Manipulation and Cleanup

The function sub_456268 manages directories associated with Firefox, Chrome, Brave, and Opera. It uses cmd.exe to move or rename browser directories and delete files, employing Sleep calls to wait for completion. This serves multiple purposes:

- **Data Theft:** Steals browser data before cleanup.
- **Anti-Forensics:** Deletes evidence to hinder recovery and post-infection analysis.
- **Adaptability:** The use of generic directory operations allows the malware to operate across different browser installations and user environments.

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```
CODE:00456291                mov     edx, [ebp+var_C]
CODE:00456294                lea     eax, [ebp+var_4]
CODE:00456297                mov     ecx, offset aMozilla ; "Mozilla\\"
CODE:0045629C                call    sub_404714
CODE:004562A1                mov     eax, [ebp+var_4]
CODE:004562A4                call    sub_4343E0
CODE:004562A9                test    al, al
CODE:004562AB                jz      loc_456341
CODE:004562B1                mov     dl, 1
CODE:004562B3                mov     eax, offset aFirefoxExe ; "firefox.exe"
CODE:004562B8                call    sub_432884
CODE:004562BD                push    9C4h            ; dwMilliseconds
CODE:004562C2                call    Sleep
CODE:004562C7                push    offset aCCdD    ; "/c cd /d \""
CODE:004562CC                push    [ebp+var_4]
CODE:004562CF                push    offset aMoveFirefoxFir ; "\" && move firefox firefox"
CODE:004562D4                lea     edx, [ebp+var_14]
CODE:004562D7                mov     eax, 6
CODE:004562DC                call    sub_432BEC
CODE:004562E1                push    [ebp+var_14]
CODE:004562E4                lea     eax, [ebp+var_10]
CODE:004562E7                mov     edx, 4
CODE:004562EC                call    sub_404788
CODE:004562F1                mov     edx, [ebp+var_10]
CODE:004562F4                mov     eax, offset aCmdExe_2 ; "cmd.exe"
CODE:004562F9                call    sub_4312C0
CODE:004562FE                lea     eax, [ebp+var_18]
CODE:00456301                mov     ecx, offset aFirefox ; "firefox"
CODE:00456306                mov     edx, [ebp+var_4]
CODE:00456309                call    sub_404714
CODE:0045630E                mov     eax, [ebp+var_18]
CODE:00456311                call    sub_4343E0
CODE:00456316                test    al, al
CODE:00456318                jz      short loc_456341
CODE:0045631A                push    offset aCDelQFS ; "/c del /q /f /s "
CODE:0045631F                push    [ebp+var_4]
CODE:00456322                push    offset aFirefox_0 ; "firefox\\*"
CODE:00456327                lea     eax, [ebp+var_1C]
CODE:0045632A                mov     edx, 3
CODE:0045632F                call    sub_404788
CODE:00456334                mov     edx, [ebp+var_1C]
CODE:00456337                mov     eax, offset aCmdExe_2 ; "cmd.exe"
CODE:0045633C                call    sub_4312C0
```

The malware uses `cmd.exe` to rename or delete browser directories

14. Credential Theft via cmdkey and NirSoft Tools

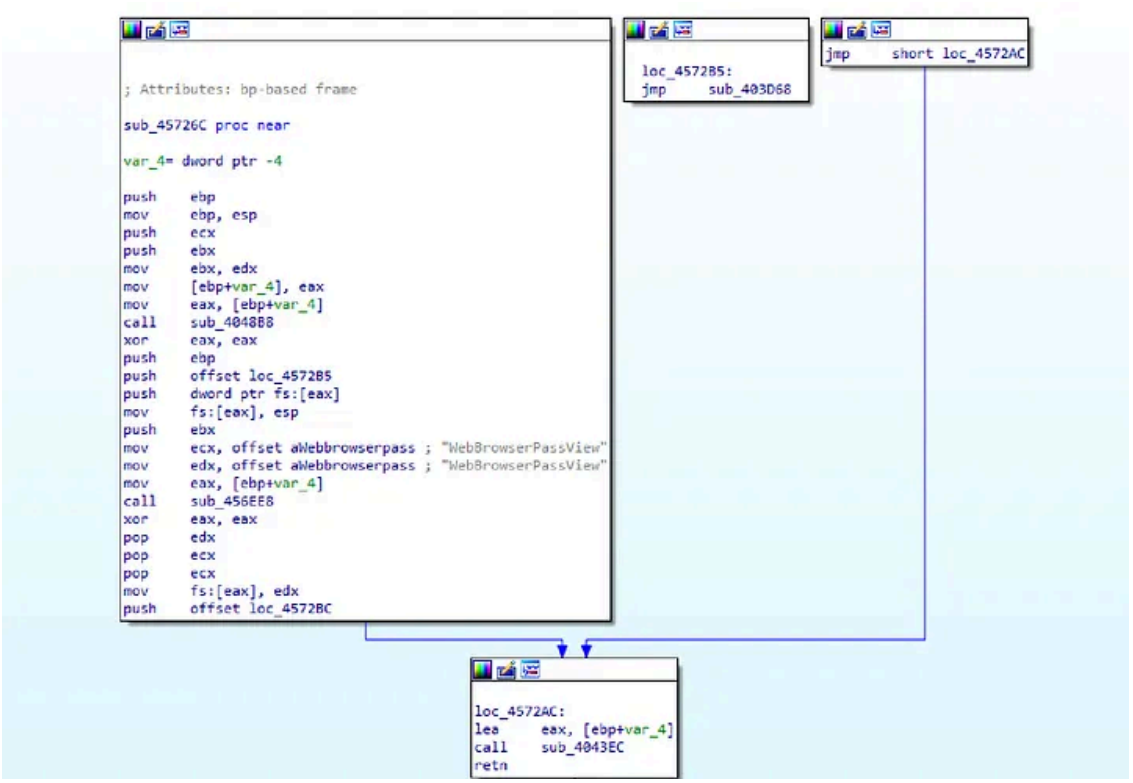
- **Windows Credentials:**
  The subroutine sub_456720 interacts directly with Windows credential management using cmdkey. It lists credentials to a temporary file and then deletes them, logging actions and waiting for operations to complete. This is a clear data exfiltration step, targeting stored Windows credentials for lateral movement or privilege escalation.

  Press enter or click to view image in full size

DarkGate uses `cmdkey` *to extract and delete Windows credentials.*

- **Browser and Email Credentials:**
  The functions sub_4571CC and sub_45726C automate the use of NirSoft's Mail PassView and WebBrowserPassView, extracting stored passwords from email clients and web browsers. This demonstrates DarkGate's ability to leverage legitimate tools for malicious purposes, maximizing credential theft with minimal custom code.

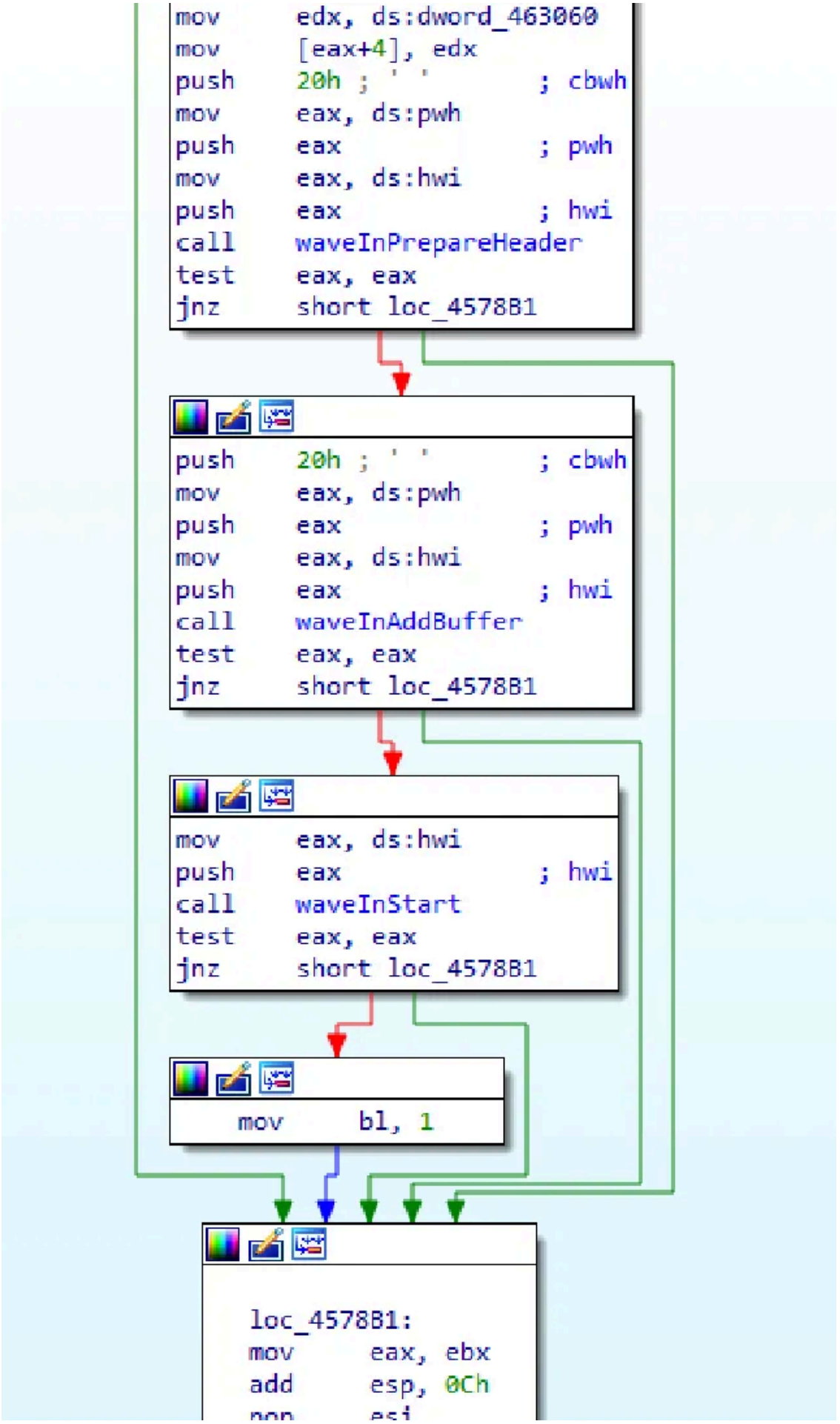
  Press enter or click to view image in full size



WaveIn API calls (e.g., `waveInOpen`) initialize audio capture from the system microphone

15. Audio Recording

The function sub_4577E0 enables DarkGate to record audio from the victim's microphone. By calling Windows multimedia APIs (waveInOpen, waveInPrepareHeader, waveInAddBuffer), the malware initializes audio input, sets up buffers, and starts capturing sound. This capability extends DarkGate's surveillance reach, allowing attackers to eavesdrop on conversations and ambient sounds in the victim's environment.


mov edx, ds:dword_463060
mov [eax+4], edx
push 20h ; ' ' ; cbwh
mov eax, ds:pwh
push eax ; pwh
mov eax, ds:hwi
push eax ; hwi
call waveInPrepareHeader
test eax, eax
jnz short loc_4578B1
push 20h ; ' ' ; cbwh
mov eax, ds:pwh
push eax ; pwh
mov eax, ds:hwi
push eax ; hwi
call waveInAddBuffer
test eax, eax
jnz short loc_4578B1
mov eax, ds:hwi
push eax ; hwi
call waveInStart
test eax, eax
jnz short loc_4578B1
mov bl, 1
loc_4578B1:
mov eax, ebx
add esp, 0Ch

WaveIn API calls (e.g., `waveInOpen`) initialize audio capture from the system microphone

DarkGate Malware — Key Functions and Capabilities

Function	Purpose	API Usage
sub_405A20	Path resolution & evasion	`GetLongPathNameA`, `FindFirstFileA`, `l
sub_40F7C8	Process/thread/module enumeration	`CreateToolhelp32Snapshot`, `Process32Fi
sub_410028	COM and data type handling	`VariantChangeTypeEx`, `VarBstrFromStr`,
sub_41CAC0	C2 communication setup	`WSAStartup`, `send`, `recv`, HTTP heade
sub_427EE4	Code injection & memory execution	`NtWriteVirtualMemory`, `NtProtectVirtua
sub_42D594	Anti-debugging detection	`Sleep`, debugger tool checks
sub_42DB04	Anti-analysis & security tool scanning	Strings: `Wireshark`, `Procmon`, `Regedi
sub_42F7A0	Debug mode & configuration loading	`CreateDirectoryW`, `GetPrivateProfileSt
sub_456720	Windows credential theft	`cmdkey /list`, file output, `cmdkey /de
sub_4571CC	Browser credential theft	`Mail PassView`, `WebBrowserPassView` au
sub_45726C	Email password theft	`Mail PassView` usage
sub_4577E0	Audio recording from microphone	`waveInOpen`, `waveInStart`, `waveInAddB
sub_456268	Browser data deletion & cleanup	`cmd.exe`, `del`, `move`, `Sleep`
sub_42C98C	Persistence via filesystem	`SHGetSpecialFolderPathW`, `SHFileOperat
sub_42E03C	Persistence via AutoHotkey	`AutoHotkey.exe`, `.ahk`/`.a3x` scripts,

MITRE ATT&CK Mapping

MITRE ID	Technique	Description
T1566.001	Phishing: Spearphishing Attachment	Initial infection via malicious email
T1059.005	Command & Scripting: AutoIt	Uses AutoIt scripts for persistence an
T1055	Process Injection	Injects shellcode using NT API calls.
T1027	Obfuscated Files or Information	High entropy and dynamic API resolutio
T1562.001	Disable or Modify Tools	Detects tools like Wireshark and Proce
T1056.001	Input Capture: Keylogging	Logs keystrokes and cursor activity.
T1555.003	Credentials from Web Browsers	Extracts saved passwords using NirSoft
T1005	Data from Local System	Harvests cookies and credential files
T1071.001	Application Layer Protocol: Web Protocols	C2 communication over HTTP using spoof
T1547.001	Registry Run Keys / Startup Folder	Establishes persistence via registry a
T1123	Audio Capture	Records audio through Windows multimed

DarkGate IOCs List

Registry Keys

- SOFTWARE\Borland\Delphi\RTL
- SOFTWARE\Microsoft\Windows\CurrentVersion\Run

- SOFTWARE\Microsoft\Windows NT\CurrentVersion
- Control Panel\Desktop\WindowMetrics

Persistence & Execution Artifacts

- AutoHotkey.exe
- Autoit3.exe
- Microsoft\Windows\Start Menu\Programs\Startup\

Credential and Data Theft

- cmdkey /list >
- cmdkey /delete:
- Mail PassView, MailPassView
- Network Password Recovery
- NetPass
- Default\Network\Cookies
- Google\Chrome\User Data\
- BraveSoftware\Brave-Browser\User Data\
- Microsoft\Edge\User Data\
- Mozilla\
- Opera Software

AV/EDR Detection & Evasion

- Bitdefender
- Avast
- AVG
- Kaspersky
- Norton
- Panda Security
- MalwareBytes
- SentinelOne
- ESET
- Avira
- F-Secure
- McAfee
- Comodo
- IObit Malware Fighter
- Emsisoft
- Quick Heal
- G DATA
- Sophos
- ByteFence

File System & Temporary Artifacts

- C:\Program Files\Bitdefender
- C:\Program Files\AVAST Software
- C:\Program Files\AVG
- C:\Program Files\Kaspersky Lab
- C:\Program Files\Malwarebytes
- C:\Program Files\SentinelOne
- C:\Program Files (x86)\Avira
- C:\Program Files (x86)\F-Secure
- C:\Program Files\Quick Heal
- C:\Program Files\ESET
- C:\Program Files\Emsisoft
- C:\Program Files\G DATA
- C:\Program Files\Sophos
- C:\ProgramData\Bitdefender
- C:\ProgramData\AVAST
- C:\ProgramData\AVG
- C:\ProgramData\Kaspersky Lab
- C:\ProgramData\ESET
- C:\ProgramData\Emsisoft
- C:\ProgramData\G DATA
- C:\ProgramData\Sophos
- C:\temp\

Command-Line & Process Injection

- /c cmdkey /list >
- /c cmdkey /delete:
- /c del /q /f /s
- /c ping 127.0.0.1 & del /q /f /s c:\temp & del /q /f /s
- /c cd /d \
- /c shutdown -f -r -t 0
- /c shutdown -f -s -t 0

C2 Communication & Network

- Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/118.0.0.0 Safari/537.36 (User-Agent)
- HTTP/1.0, HTTP/
- Authorization: Basic
- Proxy-Authorization: Basic
- 127.0.0.1
- 0.0.0.0

- 255.255.255.255

Other Notable Strings

- :::Clipboard::: (clipboard data marker)
- .0xCrypt (potential cryptographic or obfuscation marker)
- Build
- EPOCH
- NOTIFICATIONS

File Names and Dropped Artifacts

- ccleaner, system config, malwarebytes, farbar recovery, avast, startup, rootkit, autoruns, editor de registro, editor del registro, registry editor, gerenciador de tarefas, zhpcleaner, task manager, junkware removal, administrador de tareas, hijackthis, tcpview, process monitor, wireshark, taskmanager
- Phishing and lure files: Navigating Future Changes October 2023.pdf.msi, clarify_27-May_{6 random digits}.html, Job description_salary_policy_marketing products_new_list_2023.zip
- Temporary/working directories: C:\test\, C:\ProgramData\cccddcb\

Conclusion

DarkGate is a stealthy and modular malware that combines persistence, credential theft, and evasion in a compact MaaS package. Even with static analysis alone, it was possible to uncover key capabilities like AutoIt-based persistence, C2 communication, and data exfiltration. These findings highlight the malware's sophistication and the value of manual reverse engineering.

References

- **Source:** MalwareBazaar
- **VirusTotal Report:** View on VT
- **Initial Behavior:** Sandbox execution (ANY.RUN) shows immediate downloader behavior, rapid persistence establishment, and swift command-and-control (C2) initiation within seconds of launch.
